Putting Seismic Safety Policies To Work

BAY AREA REGIONAL EARTHQUAKE PREPAREDNESS PROJECT

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Putting Seismic Safety Policies To Work

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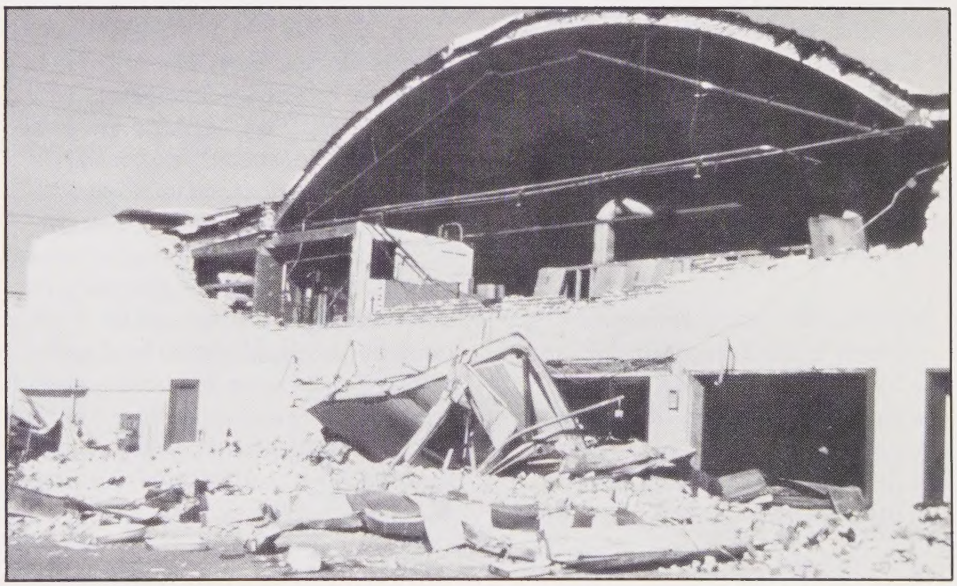
INTRODUCTION

As a local government official in California, you can expect to have the unwelcome experience of coping with a damaging earthquake. The U.S. Geological Survey recently forecast that, in the next thirty years, the Los Angeles area has a 60% chance of a major earthquake and the San Francisco Bay area a 50% chance. But, major earthquakes are only part of the problem. Moderate earthquakes, with locally heavy damage, strike much more frequently. In the last 20 years, city officials in Whittier (1987), Morgan Hill (1984), Coalinga (1983), Mammoth Lakes (1980), Eureka (1980), El Centro (1979), Santa Barbara (1978), Oroville (1975), San Fernando (1971), and Santa Rosa (1969) have dealt with damaging earthquakes. Your city could be next.

Earthquake damage threatens the physical, social and economic fabric of a community. Housing and critical community facilities may be lost. Emergency response services may be overtaxed, utility services disrupted, and businesses destroyed with consequent loss of employment and community revenue. Neighborhoods may be torn asunder and people may experience crippling anxieties long after the last aftershock. Some communities never truly recover from the impacts of a major earthquake. More than five years after a relatively moderate earthquake, Coalinga is still struggling to revive its downtown business district.

Yet, no community is helpless before this ever-present threat. This guide has been prepared to help you take a fresh look at your seismic safety policies and how you can put them to work. You can take many steps now to save lives, avert damage and protect your community from the devastating effects of an earthquake. Many effective actions require only slight changes in how you carry out typical functions of local government such as subdivision review and building inspection. At the heart of reducing earthquake losses are those actions which determine where and how the physical development of the community will take place. In California, this is the province of the general plan and associated implementing programs and regulations.

California law requires every city and county to adopt a general plan with goals and policies for physical development. The general plan must contain at least seven topical elements with goals, policies and recommended implementing actions for each element. The plan must be



Auto dealership in Alhambra, severely damaged in 1987 Whittier Narrows earthquake (photo: BAREPP)

internally consistent; zoning and subdivision regulations must also be consistent with its goals and policies. Plan policies provide the basis for many local programs, regulations and funding decisions. The policies are a bridge between your community's goals and its decisions to act.

In 1971, after the San Fernando earthquake, the California Legislature passed a law requiring that local general plans include seismic safety elements. In a 1984 amendment, the Legislature combined the requirements for a seismic safety element and safety element into a single safety element. As stated in the 1987 General Plan Guidelines by the Governor's Office of Planning and Research (OPR), the safety element "aims at reducing death, injuries, property damage, and the economic and social dislocation resulting from natural hazards." The safety element should (OPR, 1987):

- define the nature of seismic safety hazards in a jurisdiction
- assess potential risks
- establish goals and objectives to reduce risks
- develop seismic safety policies for implementation

Almost all cities and counties in California have adopted seismic safety or safety elements as part of their general plans. Public hearings on the elements created opportunities to increase public awareness of earthquake hazards. However, that awareness has not consistently led to actions to implement the policies. Many reasons can be posed for this, but the fact is that seismic losses are not reduced by words in a plan. The words must be translated into some form of action.

A general plan is implemented through a deliberately-balanced selection of measures. As stated by OPR:

Most implementation methods derive from local government's corporate and police powers. State law requires a local government to have subdivision and building regulations and open space zoning, while most other measures are adopted at local option. If the goals and objectives are to be served effectively, the implementing measures must be carefully chosen, adapted to local needs, and carried out as an integral program of complementary and mutually reinforcing actions. At the same time, they must be used to achieve results that are consistent with the general plan.

Seismic safety policies may be implemented in the course of other actions. For example, a community that acts to improve its plan checking and building inspection is taking an important step to improve the earthquake resistance of its new buildings. You can make a significant difference simply by considering seismic risk in the conduct of day-to-day business. Many measures that effectively reduce seismic risk are not extraordinary; they require slight adjustments to normal local government activities.

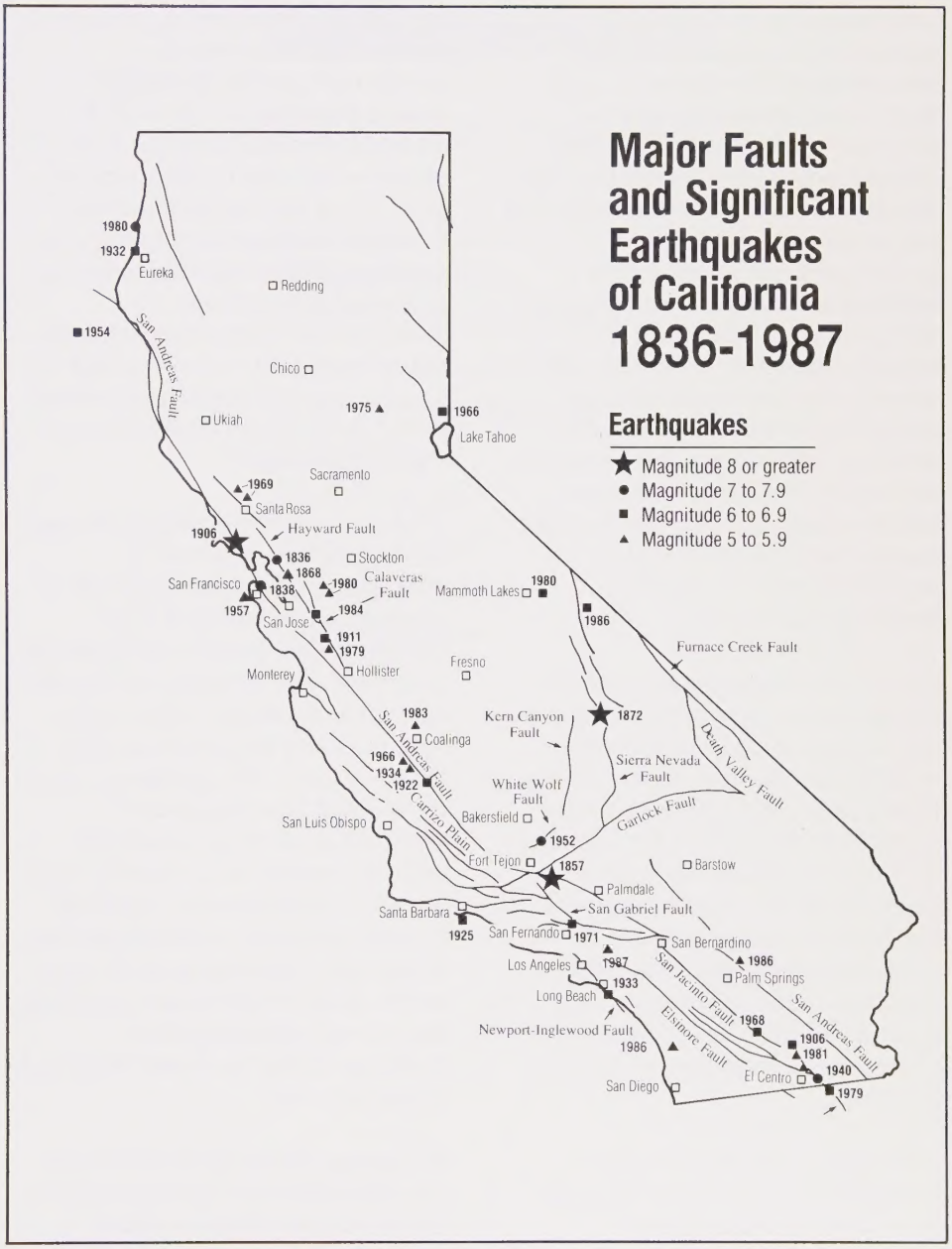
Seismic safety policy is implemented as you carry out your responsibilities under CEQA (California Environmental Quality Act, Public Resources Code Section 21000 et seq.). CEQA requires that you consider the seismic and geologic setting prior to approval of most significant development projects and actions of local governments. The mandated environmental assessment is a very important way in which information on earthquake hazards is interjected into the local decisionmaking process. Using this information wisely will reduce your jurisdiction's potential earthquake losses.

Many actions that reduce risk from other hazards such as fire, storms, flooding, and landslides also reduce

risk from earthquakes. For example, restricting development of unstable slopes reduces landslide hazards caused by heavy rains and earthquakes, and buildings designed and constructed to resist earthquake forces better withstand high winds. In developing a program, it pays to look for the measures with multiple benefits.

One common obstacle to implementation is that seismic safety policies are usually the creations of the planning staff and Planning Commission, but responsibility for key actions often rests with others. For example, the building department enforces building codes; the public works department carries out the strengthening of public facilities; the fire department conducts safety inspections of commercial and industrial buildings; and the emergency services department assesses risks and prepares to respond. Each city and county has its own organization and names for the departments, but all these functions are rarely combined. Thus, putting together a successful program to implement seismic safety policy always requires cooperation among departments.

This report tells how your city and county can move from formulating seismic safety policies to actions that reduce seismic risk. It describes



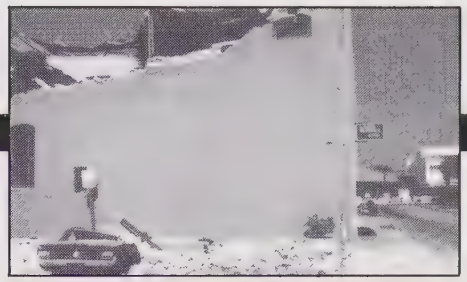
some measures that you can take to address ten issues pertaining to seismic safety. The issues focus on the physical development of a community which is an important determinant of its vulnerability. The objective is to define those things that you, as an official of local government, can do before the earthquake strikes that will directly reduce damage. Measures to improve emergency response and recovery are very important and must be taken by all communities; however, they are not emphasized in this report. The focus is on those actions which can lessen earthquake damage and, therefore, reduce the requirements for emergency response and recovery.

For each of the ten issues, we have identified the importance of the issue and impacts on local governments. In each case, the first step in moving from a policy to action is to clarify the hazard and options for reducing it. This is an information-gathering and analysis step that is necessary but, by itself, will not reduce earthquake damage. Successful implementation requires moving beyond this first step to one or more of the general strategies which are described.

Each issue is accompanied by examples of actions taken by local governments in California to implement seismic safety policies. A policy statement from the jurisdiction's safety element is quoted at the beginning of each example. In some cases the link between the policy and the action is more direct than in others. Often actions that reduce earthquake risks are taken without specific reference to general plan policies. Nevertheless, the policy statements are an important part of the context and rationale for action and become particularly important if actions are legally challenged.

We have included examples because no single list of measures or strategies can be either complete or relevant to the variety of local circumstances. Some of the example programs were initiated many years ago; some are recent. Many of the specific examples pertain to more than one issue. We encourage you to think about how the general approach used in each example could be applied in your community. We have emphasized examples of hazard reduction in public buildings, recognizing that local governments will be far more credible in requiring hazard reduction in private buildings, if they have put their own houses in order.

We have used examples also to let you know that local governments in California are acting to reduce earthquake hazards; that many of the actions are quite simple to take; and that a body of experience is there for your city or county to draw upon. Metropolitan and rural jurisdictions; large and small jurisdictions; valley, coastal and mountain jurisdictions are all making progress. Reducing earthquake risks is feasible, sensible, and part of good local government practice in California.



SEISMIC SAFETY ISSUES

Hazardous Buildings
Critical Facilities
High Occupancy Buildings
Hazardous Materials
Nonstructural Hazards
Rebuilding
Fault Rupture
Ground Failure
Ground Shaking
Flood Hazards

HAZARDOUS BUILDINGS

Many buildings in California are unsafe, resulting in potential loss of life or life-threatening injury. Unreinforced masonry buildings are extremely vulnerable to seismic shaking and have performed very poorly in earthquakes. The Unreinforced Masonry (URM) Law passed by the state legislature in 1986 (Government Code section 8875 et seq.) requires all cities and counties in Seismic Zone 4 to identify hazardous unreinforced masonry buildings in their jurisdictions by January 1, 1990. It further requires cities and counties to establish a mitigation program and notify building owners that their structures are potentially hazardous in earthquakes.

Unreinforced masonry buildings are not the only hazardous structures in earthquakes. Buildings with concrete tilt-up walls, soft stories, and nonductile concrete frames can be very dangerous in earthquakes. Mobilehomes and structures not properly tied to foundations also experience more than usual earthquake damage.

California Seismic Zone Map

Getting Started

CONDUCT THE INVENTORY

Building inventories include date and type of construction, number of stories, location, building use and number of occupants. You can acquire information from planning and building department files. Field surveys can verify initial data and provide more detailed information. Once a survey has been completed, it is important to classify buildings according to risk to life safety and establish priorities for hazard abatement. Each local government must consider the characteristics of its building stock in selecting the types of buildings and uses its abatement program will cover.

Damage to unreinforced masonry building in 1983 Coalinga earthquake. (photo: BAREPP)

Strategies

ADOPT CODE REQUIREMENTS

Standards for reinforcement of unsafe buildings can be less stringent than those for new construction. However, at a minimum, they must provide for life safety. You need to consider how to strengthen designated historic buildings on a building by building basis. The requirements should specify time limits for compliance based on established priorities. You might allow extensions for partial compliance. Preparing code standards requires the assistance of a structural engineer familiar with seismic design.

NOTICE BUILDINGS/ EDUCATE OWNERS

The owner of each potentially hazardous building should be notified and informed that abatement may be required. The letter should describe the seismic hazard and explain what the owner must do to determine if the building is hazardous, how to comply with the mitigation program and the time limits for compliance. Staff members should be trained and available to answer questions from the building owners.

DEVELOP ASSISTANCE PROGRAMS

Requiring seismic upgrading of buildings will have an economic impact on building owners and tenants. Financial assistance can be provided to help pay for strengthening and reduce the impacts of tenant displacement and rent increases. Examples of assistance programs include low-interest or deferred payment loans, relocation assistance and rent subsidies. When notices are given, building owners should be provided with information on available programs.

Examples

1. Santa Rosa

"Continue to provide for the identification and evaluation of existing structural hazards, and abate those hazards to acceptable levels of risk."

In 1969, the City of Santa Rosa experienced two earthquakes with magnitudes of 5.6 and 5.7 within a two-hour period, resulting in more than $5 million in damage. After the earthquake, the city addressed the problem of hazardous buildings through a combination of downtown redevelopment and a systematic program to abate existing structural hazards throughout the city. The city expanded an existing redevelopment area in downtown to include the damaged commercial area west of the original redevelopment area. Some properties were acquired and cleared for a major regional shopping center. Some buildings were demolished and others were rehabilitated.

With the assistance of a structural engineer, the city established procedures and criteria for the inspection of potentially hazardous buildings, with priority given to high occupancy buildings, critical facilities and government buildings. The inspection determined compliance with the 1955 Uniform Building Code. Buildings failing to comply with the code provisions are reviewed by a structural engineer or a civil engineer specializing in structural work, and plans must be prepared to bring the building up to the 1955 code. Where rehabilitation is required, the hazard must be abated within one year of notice by the city. These provisions were originally contained in a City Council resolution and were later adopted as an ordinance. To date, approximately 400 buildings have been inspected by the city and over 200 have been demolished or brought into compliance with the city code.

Total Buildings Identified	368
Completed or Presently Being Abated	181
Partial Compliance	9
Demolitions	23
Notice Removed	25
No Action to Date	133

For More Information Contact:
Community Development Department, City of Santa Rosa

Seismically rehabilitated building in Santa Rosa (photo: William Spangle and Assoc.)

2. Palo Alto

"Review City codes to ensure that a mechanism exists to require that public safety deficiencies are corrected by those responsible for the buildings."

In February 1986, the City of Palo Alto adopted a program to reduce hazards of existing buildings. All buildings are included in the ordinance except single-family structures and other small buildings, and buildings built after 1976 when Palo Alto adopted the 1973 edition of the Uniform Building Code. The 1973 UBC incorporated new seismic standards derived from the experience of buildings in the 1971 San Fernando earthquake. The Palo Alto ordinance applies to three categories:

Total Buildings Identified	115
Unreinforced buildings	48
Pre-1935 buildings with 100 or more occupants	18
Pre-1976 buildings with 300 or more occupants	49

Buildings falling into one of the three categories must be evaluated by an engineer to determine any seismic deficiencies. The Palo Alto ordinance does not require the owner to reduce hazards identified in an engineering report. The reports, prepared by a civil or structural engineer, are filed with the city and become a matter of public record. Mitigation action is voluntary; however, owners have begun repairing their buildings motivated primarily by concern for liability and the strong economic growth of downtown Palo Alto. The city offers an important incentive by allowing owners to increase the square footage of seismically strengthened buildings by 2500 sq. ft. or 25 percent, whichever is greater, without providing additional parking.

The last of the engineering reports, those for category 3 buildings, are due by May 1989, with an additional 18 months for historic buildings. So far 31 reports have been accepted, 13 buildings have been strengthened, and 5 are underway.

For More Information Contact:
Building Department, City of Palo Alto

Seismically rehabilitated building in Palo Alto (photo: BAREPP)

Rescue workers search for survivors after 1933 Long Beach earthquake
(photo: So. Calif. Earthquake Pictures)

3. Long Beach

"Pre-1933 buildings should continue to be the first priority for recycling as these structures constitute the most serious threat to public safety..."

Long Beach began an inventory of its hazardous buildings in the 1950's. The inventory concentrated on unreinforced masonry buildings. These buildings had performed poorly and were the cause of most of the fatalities in the 1933 Long Beach earthquake.

In 1959, Long Beach adopted an ordinance to abate earthquake hazards in about 1000 buildings identified in the inventory. Based on the concept of balanced risk, the program takes into account the occupancy and location of a building in addition to its structural earthquake resistance in establishing priorities for abatement. Three levels of risk were established and used to classify each inventoried building.

To date, the Long Beach program has resulted in the demolition of 276 buildings and strengthening of 56. All of the buildings categorized as high risk have been abated or strengthened enough to be placed in a low risk category. The remaining 603 buildings fall into the lowest risk category. The Building Department intends to have all unreinforced masonry buildings strengthened or demolished by 1991.

Total Buildings Identified	935
Buildings Completed	56
Demolitions	276
No Action to Date	603

For More Information Contact:
Department of Building and Safety,
City of Long Beach

CRITICAL FACILITIES

Critical facilities are those facilities and parts of a community's infrastructure that must remain operational after an earthquake for a community to respond effectively. Examples of critical facilities include hospitals, fire stations, electrical power plants, and communication facilities. Ability to repair and/or restore such facilities quickly after an earthquake is essential to recovery.

Critical facilities should be located, designed and constructed to withstand the effects of an earthquake. The state has established standards in some cases. For example, after the 1971 San Fernando earthquake, the state adopted the Hospital Seismic Safety Act of 1972 (Health and Safety Code Section 15000 et seq.) establishing design standards for the construction of new hospitals. The Essential Services Buildings Seismic Safety Act of 1986 (Health and Safety Code Section 16000 et seq.) regulates the design and construction of other buildings including fire stations, police stations, and emergency operation centers. However, the safety of existing critical facilities as well as new construction not covered by the above state laws is still locally regulated.

Damage to PG&E substation in Coalinga earthquake (photo: BAREPP)

Getting Started

ASSESS VULNERABILITY
Identification of critical facilities may be done as part of a hazardous building inventory. You need to assess the vulnerability of each facility. Usually a structural engineer, and often an engineering geologist or geotechnical engineer is needed. Evaluation of vulnerability includes site hazards, structural design, facility function and importance to emergency response. In addition, the importance of lifelines (gas and water lines, transportation arteries, communication lines), needs to be assessed, as not all are equally critical to the community.

Strategies

ENACT AND ENFORCE PERFORMANCE STANDARDS
Development of earthquake standards for critical facilities requires structural engineering expertise and a knowledge of the ground shaking and ground failure characteristics of the areas where facilities and lifelines are located. The standards should apply to both structural and nonstructural hazards. Standards should be set to ensure continued functioning of the facility after an earthquake.

REDUCE HAZARDS
Develop a schedule for strengthening critical facilities that must be functional after an earthquake. Many critical facilities are publicly owned and strengthening should begin with these facilities. Where adequate strengthening is not feasible, consider relocation or replacement of the facilities. Lifelines should be designed and maintained for quick restoration of service following an earthquake.

PLAN FOR SERVICE REDUNDANCY
Where existing lifelines cross areas subject to ground failure or fault displacement, backup facilities and capabilities should be provided. Examples include provisions for emergency water supplies and power generators.

Examples

1. San Francisco

"Maintain and expand the city's fire prevention and fire-fighting capability."

San Francisco's Emergency Preparedness Program, funded by a $46.2 million General Bond Issue, was passed by city voters in 1986 to improve the city's ability to fight fires following a major earthquake. The program provides funding for several projects including:

- Assessing conditions of Fire Department facilities and equipment
- Expanding the city's Emergency Coordination Center
- Increasing the Fire Department's capability to supply water to the entire city through 1) underground cisterns, 2) suction connections to lakes, the San Francisco Bay, and the Pacific Ocean, 3) high pressure pipelines, and 4) the Fire Department's Portable Water Supply System.

Engineering is underway for water supply improvements, while plans for the Emergency Coordination Center are undergoing environmental review in the city's Planning Department. The construction phase for the major portion of the program is targeted for completion by mid-1990.

For More Information Contact:
Public Works Department or Fire Department, City of San Francisco

View of the city while the fire after the 1906 San Francisco earthquake was in progress (photo: BAREPP collection)

2. Fairmont Hospital, Alameda County

"Pursue current programs or initiate new programs to identify and abate structural hazards, with priority given to the identification of hazards in critical, essential and high occupancy structures..."

Fairmont Hospital is an Alameda County public hospital in San Leandro. The Hayward Fault runs directly under several of the buildings of the campus style facility. Many lives could be lost, if a major earthquake occurs along this segment of the fault. At the least, the hospital would be heavily damaged and probably unusable. Recognizing this, the county stopped using the buildings directly over the fault. In one building, about 30 feet of the end of a wing was removed because a corner of the wing was astride the fault. Seismic strengthening is being completed one building at a time as funds are available. Funding for the work has come mainly from the county, with some assistance provided through the state. The county plans eventually to demolish and replace the existing unsafe buildings. In addition to tackling the structural hazards, the hospital also operates a hazard surveillance program to identify nonstructural hazards.

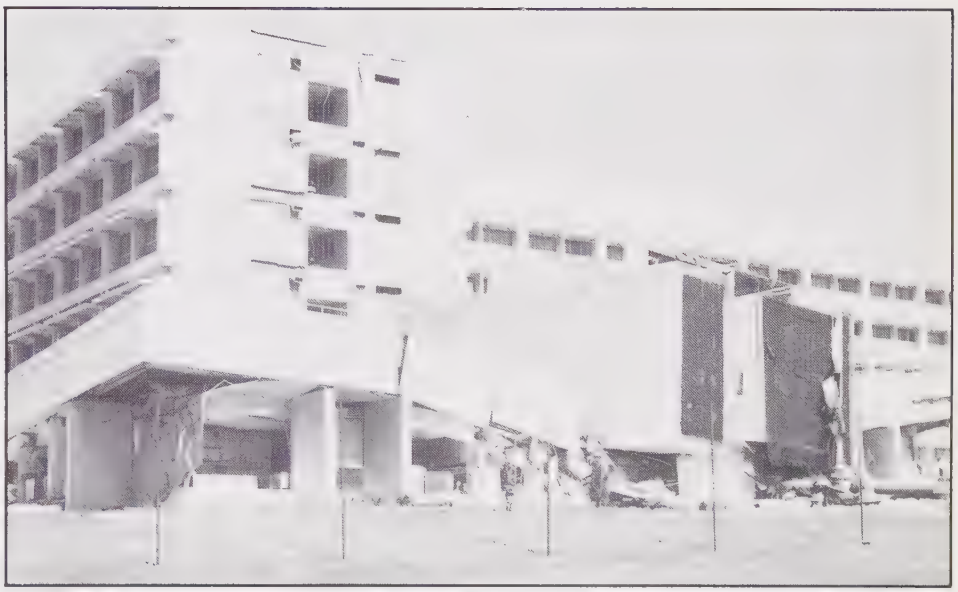
For More Information Contact:
Administrator's Office, Fairmont Hospital

A Fairmont Hospital building, sitting directly on the fault, is now boarded up. (photo: BAREPP)

This wing previously extended an additional 50 feet, but was shortened so it would miss the fault. (photo: BAREPP)

HIGH-OCCUPANCY BUILDINGS

Failure of a single high-occupancy structure can result in hundreds of deaths and injuries.
High-occupancy structures include high-rise apartments and offices, schools, auditoriums and other places of assembly. Places of assembly usually are used only occasionally, however, life loss may be very heavy if an earthquake occurs at the time of use. Seismic design is particularly important when the occupancy is involuntary, such as in schools or jails, or when the occupants are in some way disabled, such as in hospitals, nursing homes and mental institutions.



Damage to Olive View Hospital in 1971 San Fernando earthquake (photo: LA City Fire Department)

Getting Started

IDENTIFY HIGH OCCUPANCY STRUCTURES
You can identify high occupancy structures as part of the hazardous building inventory. The inventory should identify any hazardous site conditions and structural characteristics. Potentially hazardous buildings should be individually evaluated by a structural engineer and, if found hazardous, accorded high priority for strengthening under hazardous building abatement programs.

Strategies

STRENGTHEN HIGH OCCUPANCY STRUCTURES
Consider the use of life-safety standards for the rehabilitation and strengthening of high occupancy structures. Move as quickly as possible to correct deficiencies in public buildings and establish priorities and a schedule for the strengthening of private buildings.

REDUCE OCCUPANCY
When established standards can not be achieved through strengthening, you can restrict permitted occupancies to reduce the exposure to risk.

PLAN EVACUATION
High occupancy building owners or managers should be required to prepare evacuation plans. Evacuation procedures should be distributed to occupants with additional safety information. Conducting earthquake drills in high occupancy buildings helps to prepare occupants for earthquake response and can be effective in testing emergency preparedness plans.

Examples

1. Henry J. Kaiser Convention Center, Oakland

"The City should consider establishing a program to have structures highly susceptible to seismic damage either reinforced or demolished. Priority for abatement should be based on the type of occupancy and the severity of risk."

The Henry J. Kaiser Convention Center, originally the Oakland Auditorium, was built in 1916. Constructed of concrete and steel framing on settling soil, the building's condition had severely deteriorated over the years. The city's need for convention facilities led to the decision to rehabilitate the structure, including upgrading structural, mechanical and electrical systems. Funding for the project was obtained through the sale of the Oakland Museum, which the city now rents.

Because there was no change in use or occupancy, the building was not required to meet current seismic codes. However, the City of Oakland elected to voluntarily strengthen the building to improve life safety. The structural modifications were not, therefore, tied to a specific code, but the strengthening was designed by structural engineers for the project to provide an acceptable level of safety for the building occupants.

The Henry J. Kaiser Convention Center, after the strengthening. (photo: H.J. Degenkolb Assoc.)

For More Information Contact:
Building Permits Division, City of Oakland

2. Louden Nelson Community Center, Santa Cruz

"Earthquake hazardous structures should be identified and abated."

Seismic strengthening of the Louden Nelson Community Center in Santa Cruz was required when expansion of the facility was proposed. The wood-frame and concrete building, built as a school in 1929, is jointly owned by the City of Santa Cruz and Santa Cruz County. The community facility is used for daycare, youth group and senior citizen activities and community functions. When State Bond Act funds were obtained to expand the community facility, a structural inspection led to action by the Chief Building Official to close the building under the Hazardous Building Abatement Code. A complete renovation of the community center was done using funds from the federal Community Development Block Grant program, state, county and city funds. Plans for upgrading the existing structure were prepared by a structural engineer. The addition was designed to meet current seismic standards of the Uniform Building Code. Seismic work to bring the building up to code included anchoring the roof to the walls, anchoring the building to the existing foundation and construction of shear walls to increase stiffness.

Children playing in front of the recently reopened community center (photo: Bill Lovejoy)

For More Information Contact:
Parks and Recreation Department,
City of Santa Cruz

HAZARDOUS MATERIALS

Hazardous materials used daily by industries, local businesses and households pose a serious threat to a community if not handled and stored properly. Earthquakes and hazardous materials are a lethal combination. Earthquakes can cause pipeline breaks, tank failures, falling containers and transportation accidents all of which can result in releases of hazardous materials. By state law, each city and county must maintain an inventory of hazardous materials and, in turn, assess the health and environmental risks posed by their use and storage. The U.S. Environmental Protection Agency and the State of California (Health and Safety Code Section 25500 et seq.) require users of certain hazardous chemicals to submit reports to a state commissioner, who is, in turn, required to notify local governments.

Getting Started

LOCATE AND IDENTIFY HAZARDOUS MATERIALS
Not all hazardous materials are covered by the current reporting requirements and not all businesses and industries will comply with the requirements. You need to look beyond the reports to find out where and how significant quantities of hazardous materials are being handled, stored and discarded in your community. Much of this information may be acquired during routine fire safety inspections of commercial and industrial properties.

Strategies

REQUIRE REINFORCEMENT OF STORAGE FACILITIES
Structural engineers should evaluate existing buildings, storage tanks, and key equipment for earthquake resistance. Conditions reported as hazardous should be corrected at once. Structures holding hazardous materials should be included as part of your hazardous building inventory and given high priority in your abatement program.

ADOPT ZONING REGULATIONS
Through the zoning ordinance, you can restrict the use and storage of specified hazardous materials to certain industrial or commercial zones to reduce the exposure from spills. Restrictions are particularly appropriate near residential areas and areas where heavy damage is expected in an earthquake because of geologic conditions. In the vicinity of critical facilities, release of these materials would compound other emergencies and threaten lives. Where use and storage of hazardous materials are allowed, special use permits should be required setting forth conditions to be met to maintain the use.

Brace on a xylene tank (photo: ABAG)

Examples

1. Union City

"The use, storage and transport of toxic, explosive or other hazardous materials should be strictly controlled."

Union City's Hazardous Materials Management System was developed through a joint effort of the city's community development department, fire department and hazardous materials specialist. The city amended its zoning ordinance replacing the "heavy" and "light" industrial zone categories with industrial zones to accommodate specific uses and categories of use. At the same time, the Table of Permitted Hazardous Materials was incorporated into the ordinance indicating the permitted on-site quantities and uses of hazardous materials in each of the city's industrial zones. In addition, the city amended the Uniform Fire Code to provide supplemental regulations regarding handling, storage and reporting of hazardous materials. Users of hazardous materials are required to provide the city with a Hazardous Materials Management Plan which includes information about handling and monitoring procedures, employee training and contingency plans.

For More Information Contact: Fire Department or Community Development Department, Union City

2. Sunnyvale

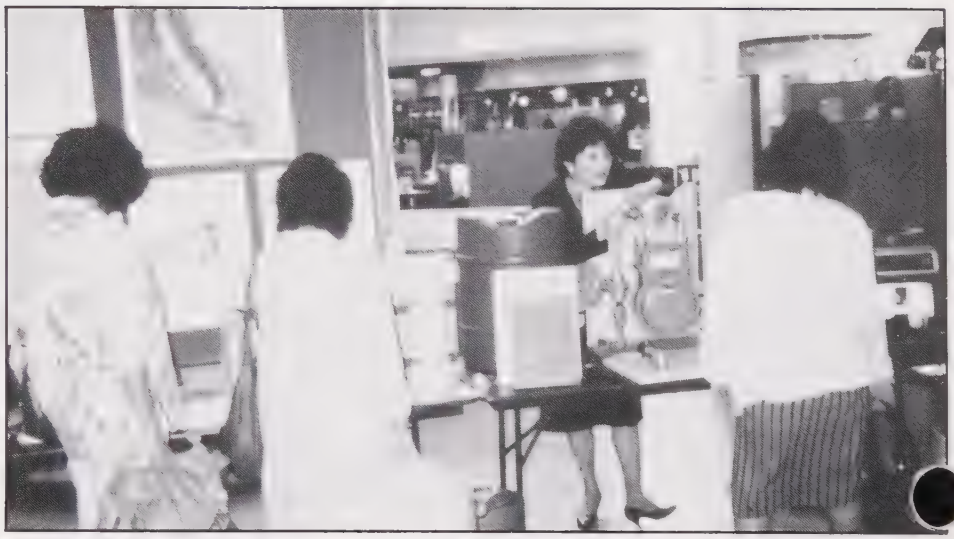
"Promote a living and working environment safe from exposure to hazardous materials."

The City of Sunnyvale, by adopting Title 20, Storage of Hazardous Materials as part of its City Code, made a commitment to reduce risks associated with hazardous materials. The ordinance was adopted to prevent and control unauthorized discharges of hazardous materials. A permit is required for the storage of hazardous materials. Before the city will issue a permit, the applicant must comply with primary and secondary containment provisions and submit a Hazardous Materials Management Plan. In addition to enforcing the ordinance, Sunnyvale has funded advanced training of key staff members in how to prevent and respond to releases of hazardous materials. Members of the Sunnyvale Public Safety Department are supported by the city as participants in efforts to develop standards for Uniform Fire Code governing hazardous materials storage containers.

For More Information Contact: Department of Public Safety, City of Sunnyvale

NONSTRUCTURAL HAZARDS

Many injuries in earthquakes are caused by the collapse or failure of nonstructural building elements in modern as well as older buildings. Such elements include office equipment, air conditioners, freestanding partitions, shelving, ceilings, light fixtures and exterior building ornamentation. Dangers in residential buildings include shelving, glass and water heaters. Most nonstructural items are not analyzed by engineers, but specified by subcontractors such as mechanical engineers and interior designers or purchased by owners or tenants after construction of the building. Even during a moderate earthquake, equipment and building contents are major safety hazards. Nonstructural earthquake damage results not only in injury, but in property loss and interruption of essential building functions.



Shopping mall display of nonstructural hazards and home preparedness items (photo: Daly City Fire Dept.)

Getting Started

DEFINE THE PROBLEM

Nonstructural elements of a building which pose a threat to life safety should be identified and priorities established for reducing the hazards. The priority should take into account the type of hazard and the building function. The best place to start is with the nonstructural elements in your public buildings. The experience gained can be passed on to private building owners and businesses.

Strategies

ADOPT LOCAL ORDINANCES TO REDUCE NONSTRUCTURAL HAZARDS

The Uniform Building Code, typically adopted by local jurisdictions to regulate building design and construction, pertains only to building components in place at the time a certificate of occupancy is issued. Local governments can adopt ordinances, in addition to the Uniform Building Code, to reduce nonstructural hazards in new and existing buildings. Such ordinances could require the strengthening or removal of exterior ornamentation and appendages, bolting of interior freestanding elements, and bracing of suspended ceilings.

DEVELOP A PUBLIC INFORMATION PROGRAM

Many nonstructural hazards can be reduced with little expense or effort. With some technical guidance and, perhaps seed money, local volunteer agencies can initiate and carry out programs to inform managers of businesses, institutions, schools and other facilities and households about simple and inexpensive steps that can be taken to reduce risks from nonstructural hazards.

Examples

1. Mountain View

"Identify seismic and general hazards, reducing existing hazards through mitigating measures where possible."

The City of Mountain View Police Services, Fire Administration and Emergency Communications are located in a single building which is also the Emergency Operations Center and could be used as an alternate City Hall in the event of a disaster. The building must remain functional after an earthquake. The city hired consultants to prepare a structural and utility system evaluation, as well as a room by room inventory of the building's nonstructural hazards. Risk factors were assigned to each item in the inventory. High risk situations are being corrected first. Communications equipment was braced and interior glass is being replaced with safety glass or covered with a safety film. The city's maintenance staff is providing the estimated 320 man-hours to complete the nonstructural work during the next year. Any structural strengthening will be done by an outside contractor. Information gained from this experience will be used to reduce nonstructural hazards in the design of Mountain View's new Library and City Hall.

For More Information Contact: Fire Administration, City of Mountain View

This damage to county offices in the 1979 El Centro earthquake is type of damage the Mountain View program will hopefully avert (photo: BAREPP)

2. Los Angeles County

"Anchoring of nonstructural elements that could cause damage in the event of an earthquake should be encouraged."

Los Angeles County worked with Southern California Earthquake Preparedness Project (SCEPP) to train 1,000 staff members to identify nonstructural hazards in the more than 5,000 buildings owned and operated by the county. The training was divided into four groups of 200-300 people each. The first three groups were composed of Building Emergency Coordinators who are responsible for assessing damage and preparing building damage reports after an earthquake. These groups were trained to conduct the inventory of nonstructural hazards. The fourth group came from the Los Angeles County Department of Facilities Management, which is responsible for maintenance and repair. This group was given intensive training methods to mitigate nonstructural hazards. The training was funded as a part of a $131 million program which also includes building a new emergency operations center and abating hazardous buildings.

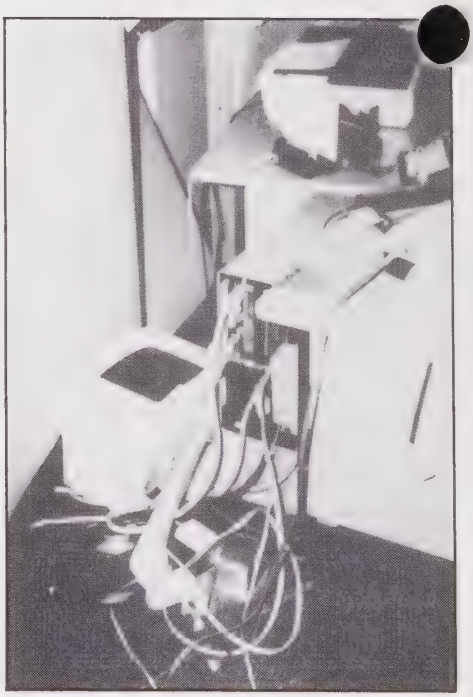
For More Information Contact: Department of Facilities Management, Los Angeles County

3. Orange County Fire Department

"To encourage establishment of seismic design criteria and standards for county facilities, any structures housing necessary mobile units and support equipment, and other vital resources which would be needed following an earthquake."

Under direction of the Board of Supervisors, the Orange County Fire Department developed a program to mitigate nonstructural hazards in fire stations. One fire station was used as a model for the program. With technical assistance from SCEPP, an inventory of nonstructural hazards was prepared which included an itemized list of costs and man-hours required to mitigate the hazards. High priority issues such as securing communications equipment were addressed first, using the department's own budget and manpower. The process was documented and a slide show prepared portraying how the inventory and mitigation work was done. The slide show is an important part of an education effort to encourage other fire stations in the county to take similar action. The slide show has also been presented to other cities and counties in Southern California. The Fire Department is seeking approval of the Board of Supervisors of funding to mitigate nonstructural hazards in other county buildings.

For More Information Contact: Fire Department, Orange County



Typical damage to unanchored computers in a moderate earthquake (photo: Wesley Van Osdol)

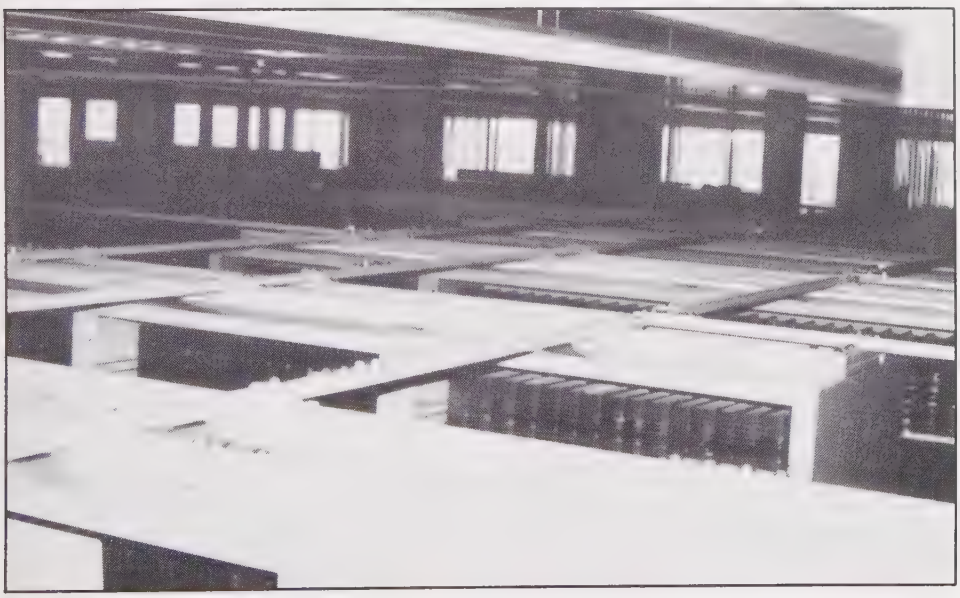
4. Santa Clara County Building

"A long range hazardous building inspection program should be planned with the critical structures given high priority."

Santa Clara County efforts to reduce damage from nonstructural hazards were proven successful in a real test. The Santa Clara County Government Center Building was struck by moderate earthquakes in both 1984 and 1986. The government center is a 13-story, steel frame building constructed in 1976. The building is designed for flexibility to prevent structural damage from ground shaking. However, in both earthquakes, the building continued to sway after the initial ground motion. This caused toppling of file cabinets, equipment, shelving and other unattached items.

The 1984 earthquake, centered in Morgan Hill, caused minimal structural damage to the building, but damage to nonstructural elements was extensive. After the 1984 earthquake, the county took steps to reduce the risk of nonstructural damage in future earthquakes. Because the building has an open floor plan, it was not feasible to bolt furniture and shelving to walls. Instead, building operations personnel devised alternative methods of bolting furniture and shelving together to increase stability in the event of movement. For example, bookshelves in the law library on the ninth floor were bolted together and steel bracing was run across the top of the shelves. These shelves, which had fallen in the 1984 earthquake, remained upright when the 1986 Mt. Lewis earthquake hit. In this earthquake, most of the damage was to items that had not yet been bolted. The county prepared a slide show documenting the damage from the 1984 earthquake. The slide presention is included in the safety/risk management part of the leadership training program for county managers.

For More Information Contact:
Department of Risk Management, Santa Clara County



Shelf bracing in the library in the Santa Clara County Government Center (photo: Wesley Van Osdol)

REBUILDING

A major earthquake will destroy a large portion of a community's built environment. In past earthquakes, pressure to rebuild quickly has resulted in overlooking opportunities to improve seismic safety. After an earthquake, people naturally want everything to be "back to normal" as soon as possible, creating strong political, economic and social pressures for rebuilding in the same location. Decisions on temporary housing and rebuilding can limit options for long term rebuilding. Planning ahead for rebuilding and reconstruction is an important step in ensuring that the community will be safer in the next earthquake.

Getting Started

IDENTIFY HIGH-RISK AREAS
Identify hazardous areas such as areas of potential ground failure or with concentrations of hazardous buildings that are most likely to need rebuilding after an earthquake. For each area, identify specific rebuilding problems and opportunities and decide if any major changes in land use or density are warranted. In such cases, prepare conceptual plans to guide rebuilding.

Strategies

ESTABLISH RECONSTRUCTION PROCEDURES AND AUTHORITIES
Typical redevelopment powers are needed to manage reconstruction effectively. Authority for your jurisdiction's legislative body to condemn, plan, buy and sell property, and receive and allocate public funds should be in place prior to an earthquake.

ASSESS DAMAGE
Immediate inspection and evaluation of damaged buildings is very important after an earthquake. You need to plan in advance how to retain structural engineers to assess damages and determine which buildings and facilities are unsafe. It is also important to quickly identify hazardous sites, particularly sites where ground failure occurred, to prevent rebuilding in areas that are likely to fail again. Geologic expertise is needed to evaluate such sites.

ADOPT CODES FOR REPAIRS
Codes for repairing damaged buildings need to be adopted before an earthquake so that rebuilding can be carried out in a timely and effective manner. The code may permit repairs at standards below those required for new construction, but should ensure that rebuilt structures will survive future earthquakes. Changes in use and occupancy levels may be required to reduce future exposure.

ADOPT CONTINGENCY LEGISLATION
Contingency legislation should be adopted to facilitate short-term recovery. For example, public parks may be prezoned to permit temporary housing after an earthquake and public land may be predesignated for temporary business locations and community facilities.

Aerial view of Coalinga Plaza after the 1983 earthquake. (photo: John Kariotis)

View of the same area four years after the earthquake (photo: BAREPP)

Examples

1. Coalinga

"The County should institute an inventory program to assess the existence and location of unreinforced masonry structures . . . and establish a program to remedy the existence of such unsafe structures."

Coalinga had a redevelopment agency and redevelopment plan covering a portion of its downtown in place when a magnitude 6.7 earthquake struck in May 1983. Downtown Coalinga had a great many unreinforced masonry buildings which were severely damaged in the earthquake. The city used its existing redevelopment authority and plan as a starting point. It then expanded the redevelopment area to include the whole city in order to use tax increments to help finance the recovery. It revised its plan granting the redevelopment agency the power to acquire commercial property by condemnation and to demolish substandard buildings.
Approximately two months after the earthquake, Coalinga enacted the following provisions to speed up the redevelopment process to deal with the pressures of recovery:

- simplified hearing and noticing for projects
- shortened waiting periods for filing redevelopment plan reports
- relaxed limitations on financing of new construction

The redevelopment plan provided a much needed framework for the rebuilding and rehabilitation of damaged parts of Coalinga after the earthquake.

For More Information Contact:
Planning and Development Department, City of Coalinga

2. Los Angeles

"Following a major disaster, the City shall be rebuilt in accordance with established general plan objectives and policies and appropriate City codes."

The City of Los Angeles has begun the process of preparing a plan for recovery and reconstruction following an earthquake.

The effort is under the direction of the Emergency Operations Board, which is chaired by the city's chief of Police and made up of nine general managers representing the major departments of the city. The first phase in developing a recovery plan will be to address major policy areas such as economics, private property rehabilitation, land use and legislation. Policy statements will be developed for each of the areas. During the second phase, actions necessary to implement the policies will be identified, the plan will be drafted and approved and programs, resources and authorities established. Recovery and reconstruction planning is an interdepartmental effort and is part of the normal workload of thos involved. No special funding is recieved for this program.

For More Information Contact:
Planning Department or Office of Emergency Management, City of Los Angeles

Local business preparing to reopen after 1987 Whittier earthquake (photo: BAREPP)

In the event of a disaster, our first priority is protecting people's lives. But we cannot ignore our responsibility to protect people's livelihoods as well. If we can't ensure that our residents will be able to live and work relatively soon after a massive quake, the future of the city will be put at risk. ... I'm proud to say that Los Angeles is now ahead of every city in the country in planning for post-earthquake recovery.
Mayor Tom Bradley

FAULT RUPTURE

Earthquakes can cause large vertical or horizontal displacements of the ground surface along the fault. Structures built across a fault or in close proximity to a fault will be destroyed in the event of rupture. It is very difficult to design a building that can withstand severe ground displacement.

In California, the Alquist-Priolo Special Studies Zones Act of 1972 (Public Resources Code Section 2621 et seq.) was enacted to prevent construction of buildings for human occupancy on an active fault. Under this act, the California Division of Mines and Geology (CDMG) identifies active faults and maps fault zones throughout the state. Applications for most development projects within these zones must include geologic studies prepared by a geologist.

Getting Started

IDENTIFY FAULT ZONES

In preparing a seismic safety element, you must gather sufficient information to assess the potential for fault rupture in the community. The first step is to obtain maps of Special Studies Zones from CDMG. Additional technical information and mapping may be obtained from a number of sources including CDMG, U.S. Geologic Survey, local colleges and universities, and geologic reports on file with your jurisdiction. Beyond determining the location of active and potentially active faults, you need any available information on the type of movement that can be expected along a fault, the probable maximum magnitude, and expected recurrence intervals.

Strategies

ADOPT LOCAL REGULATIONS TO IMPLEMENT THE SPECIAL STUDIES ZONES ACT

The Special Studies Zones Act provides the framework for local governments to prevent damage from fault rupture. Local regulations must be consistent with the criteria adopted to implement the Special Studies Zones Act which specify when geologic reports are required, who reviews them and where development is prohibited. The act also provides that a city or county may establish more restrictive policies if desired.

ADOPT GUIDELINES FOR CONDUCTING FAULT INVESTIGATION

Regulatory measures for avoiding or reducing the hazards of fault rupture commonly require detailed investigations to accurately identify and evaluate the fault. Cities and counties must establish guidelines for conducting site specific investigations in the fault zone. The guidelines should make clear to owners and geologists what information is required for geologic investigations.

ADOPT LAND USE POLICIES AND REGULATIONS FOR THE FAULT ZONE

The Special Studies Zone Act prohibits certain land uses on identified fault traces, however, it is the task of local governments to determine land uses for fault zones and establish zoning restrictions. Appropriate low-intensity land uses for fault zones include open space and parks, agriculture and parking lots. Whenever possible, lifelines and critical facilities should not be located in fault zones, particularly across active faults.

Aerial view of the San Andreas fault through the Carrizo Plain (photo: Bob Wallace, U. S. Geological Survey)

Examples

1. Riverside County

"Seismic and geologic hazards shall be recognized as significant constraints in determining suitable land uses and structural design."

As a result of a technical report done for the preparation of the county's general plan, Riverside County has established County Fault Hazard Zones which designate areas of potentially active and recently active faults which were not identified by CDMG as Special Studies Zones. These zones are designated on the County Seismic Hazards Maps which also contain Special Studies Zones, groundshaking zones, liquefaction hazard areas and slope instability areas. These seismic hazard maps are included in the general plan. The county's assessor parcel books have been flagged to identify parcels in the Special Studies Zones. Any application for construction of a structure for human occupancy in a fault hazard zone must include a geologic report. If an active fault is found during trenching, which is supervised by the county geologist, the county requires an Environmental Constraint Sheet which identifies the fact that a geotechnical report exists and outlines the required setbacks. To ensure site conditions are recorded as found, the reports are kept on file with the Planning Department and are also logged into records of the Building and Safety Department.

For More Information Contact:
Planning Department, Riverside County

2. Hayward

"Specific regulations pertaining to existing structures...both inside and outside the fault corridor, will be adopted, as necessary, to assure the public safety."

The Hayward Fault, capable of producing a magnitude 7.5 earthquake, runs through the center of Hayward. The city's seismic safety element, adopted in 1972, defined a "fault corridor" of high seismic risk. Among other uses, city hall and the police station were in the fault corridor. A new civic center complex, containing city offices including the police department, was built on the edge of downtown outside the fault zone. It has helped to attract other economic activity away from the fault zone. A redevelopment plan for downtown features some reduction in use of the fault corridor. Several parcels of land within the fault zone have been rezoned for parking. The old city

hall remains, although the building occupancy has been reduced while the city determines its future use.

For More Information Contact:
Planning Department, City of Hayward

3. San Andreas Fault Trail, Santa Clara County

"Where urban development has not yet occurred in areas that have geologic constraints... the major land uses should be largely open space uses."

Santa Clara County receives help from a special district in implementing this policy. In 1972, voters in parts of Santa Clara and San Mateo counties created the Midpeninsula Regional Open Space District (MROSD) to acquire and preserve open space lands. The district, an independent government agency, purchases and manages open space lands in the two counties. A policy of the district is to acquire undeveloped lands subject to hazardous conditions for the protection of public health and safety. Funding is provided through property tax revenues.

One of the district's open space areas in Santa Clara County is the Los Trancos Open Space Preserve. Located just east of Skyline Boulevard in the Santa Cruz Mountains, the 274-acre preserve is split by the San Andreas Fault. Within the preserve, the district has created the one-mile San Andreas Fault Trail along the fault zone as a self-guided, interpretive trail. Using the district's information brochure, hikers can follow the trail markers and learn about plate movements, sag ponds, benches and scarps.

For More Information Contact:
Midpeninsula Regional Open Space District

A fault trace runs directly under Old City Hall in Hayward; city offices have been relocated . (photo:BAREPP)

GROUND FAILURE

Earthquake ground shaking is capable of generating many kinds of ground failures including landslides, debris flows, rock slides and settlement. Some ground failures during earthquakes are caused by liquefaction. Damage to buildings from ground failure is often total and it is particularly difficult and expensive to design and build structures to withstand ground failure. Development in areas of potential ground failure should be avoided or carefully engineered for the site conditions.

Getting Started

IDENTIFY AREAS SUBJECT TO GROUND FAILURE

The background report for your safety element should provide accurate and up-to-date information identifying areas of potential ground failure hazards. You may get additional information from local colleges and universities and geologic consultants. Your options for responding to the hazards depend on the accuracy with which they are identified.

Strategies

GEOTECHNICAL REVIEW

Development of a site with identified ground failure hazards should not be approved unless supported by the results of detailed geotechnical and/or engineering geology investigations. The investigation report should evaluate the site hazards in relation to the proposed development and recommend site preparation and construction measures to mitigate the hazards. You must have a person trained in geology to review the investigation reports for your jurisdiction. This person may be a staff geologist, a consultant or a geologist shared with other jurisdictions.

SUBDIVISION REGULATIONS

If there is any indication of hazards, you should require detailed geologic investigations of sites proposed for subdivisions. Such investigations are essential to confirm that all lots created are, or can be engineered to be, safe building sites and that all public improvements will be located and engineered to avoid damage from geologic hazards. By identifying hazards at this point in development, building sites may be clustered to avoid hazardous areas, road rights-of-way located to prevent failures or maintenance problems, and open spaces planned to coincide with hazardous areas. Once land is subdivided, it is very difficult to redesign a development pattern to reduce losses from ground failure.

HAZARD/OPEN SPACE ZONING

Zoning can be used effectively to mitigate hazards from ground failure in undeveloped areas. Avoiding or restricting development in areas prone to ground failure is often easier than trying to design structures to withstand potential failure. Such areas can be zoned as open space or for low-intensity uses to avoid the potential risks. In some cases, it is possible for a jurisdiction to acquire potentially hazardous land for public parks or arrange for acquisition by an open space district.

PLAN CHECK/DESIGN REVIEW

Where zoning permits construction in areas prone to ground failure, hazard mitigation measures need to be carefully reviewed. Recommendations in geotechnical and engineering geology reports need to be fully implemented. The building permit and inspection process provides the means to ensure that construction plans adequately reflect the geotechnical recommendations and site conditions and that site development and construction occurs as approved.

Examples

1. Belmont Geologic Hazards Ordinance

"The City shall require investigations by both registered soils engineers and engineering geologists prior to issuing building permits for any new construction unless waived due to current existing information and location."

The San Juan Hills area of Belmont is a partially developed area with an old and unworkable subdivision and steep hillsides situated about one mile from the San Andreas Fault. Recognizing potential development problems, the city retained an engineering geologist to prepare a geologic map and ground movement potential map for the area at a scale of 1" = 200'. The maps were based on aerial photographs, field investigations, and other geologic studies. Both maps were recently adopted as official maps of the city as part of an ordinance to regulate development in the area based on slope stability. The ordinance:

- Establishes categories of land use permitted within each mapped geologic unit
- Specifies requirements for geologic reports
- Establishes procedures for modifying the map and for granting exceptions to the land use criteria.
- Clarifies the role of a city geologist in reviewing applications for geologic reports.

Land use restrictions and geotechnical/engineering geology report requirements established in the ordinance apply in considering applications for building and grading permits, rezoning, formation of assessment districts and divisions of land.

For More Information Contact:
Planning and Community Development Department, City of Belmont

LAND USE CRITERIA

map symbol	geological conditions	land use: houses	land use: roads	land use: schools
Sbr	Bedrock	Y	Y	Y
Sun	Unconsolidated sediment	Y	Y	*
Sex	Expansive soil	*	Y	*
Sff	Fill on flat ground	*	*	*
Pfs	Fill on a slope	*	*	*
Ps	Potential shallow landslide	*	*	*
Pd	Potential Deep landslide	*	*	*
Ms	Moving shalllow landslide	*	*	*
Pdf	Potential debris flow	N	*	N
Md	Moving deep landslide	N	N	N

Y Yes (permitted)
* Acceptability of use depends on results of detailed geologic investigation
N No (not permitted)

As modified from the Belmont Geologic Ordinance by William Spangle and Associates, Inc.

Permitted land uses in Belmont Ordinance

2. San Bernardino County

"Discourage the locating of critical facilities and structures for human occupancy on potentially active faults or on certain potential landslides and the path of their earth flow."

Anticipated landslide activity in the event of heavy rainfall and/or earthquakes in San Bernardino County has led to the adoption of a Landslide Ordinance. The ordinance establishes regulations for structures and development on, or adjacent to landslides or within areas that have a history of landslide activity. A geotechnical report must be submitted with an application for a project in such a location. The report must evaluate the stability of hillsides during anticipated seismic accelerations. A map of identified landslide areas is part of the zoning ordinance. The California Division of Mines and Geology is currently mapping landslides in the county in greater detail than the current maps. The county also plans to sponsor publication of a volume of topical papers on landslides by the Inland Geological Society. These papers provide the county with a substantial base of information for landslide identification amd classification.

For More Information Contact:
Land Management Department, San Bernardino County

3. Santa Clara County

"Procedures should be established for investigation, design, construction and inspection of developments in those areas of the Baylands which have a higher soils and geologic risk to life and property than other areas in Santa Clara County."

The Santa Clara County Baylands Plan (1972), aimed at reducing risk to life and property, covers an area subject to settlement, lateral spreading and liquefaction. A study of the planning area's hazards was done by geologic and structural engineering consultants. The planning area was divided into risk zones based on potential for ground settlement and ground failure. Appropriate land and building uses were identified for each of the risk zones. The Baylands Plan adopts the uses and recommends that the county require a soils report showing that any proposed development site is not in a higher risk zone than shown. Based on this plan, the county adopted an ordinance requiring geologic reports and site investigations for any subdivision on or adjacent to a potentially hazardous area which is depicted on the official county hazard maps.

For More Information Contact:
Land Use and Development Department, Santa Clara County

GROUND SHAKING

Ground shaking typically causes most of the damage in earthquakes. However, it is one of the most difficult hazards to predict and quantify. Damage to the built environment caused by ground shaking depends on the characteristics of the earthquake, distance from the fault, soil conditions, building design and engineering, and construction. In California, the state adopts the current Uniform Building Code and mandates that local government codes meet or exceed these building standards for residential construction. Each time an earthquake occurs, engineers learn more about how to design buildings to withstand seismic forces. As code provisions are updated, they should be adopted by local governments.

Getting Started

IDENTIFY AREAS OF STRONG SHAKING

Ground shaking may be amplified in unconsolidated sediments such as bay mud and unengineered fill. Shaking is usually very strong in areas adjacent to faults. Such areas should be identified and evaluated. Special standards may be established applying to construction in these areas.

The ground shaking in the 1985 Mexico City earthquake was severe enough to cause the collapse of this school. (photo: E.G. Hirsch)

Strategies

TRAIN STAFF FOR PLAN REVIEW

Local building officials responsible for reviewing construction plans and issuing required building permits must be qualified to assess seismic resistance of building design. A structural engineer should be available to review plans for major structures.

DEVELOP INSPECTION PROCEDURES AND TRAIN INSPECTORS

To reduce earthquake damages, building code provisions must be applied adequately in construction. Careful monitoring of construction progress through building inspections at appropriate stages is essential. You need well-trained building officials to inspect projects at several stages of construction for conformity with approved plans and specifications.

Examples

1. Redwood City

"Amend the Uniform Building Code, as frequently as may be prudent, to incorporate into its tables lateral force shear values to be applied to new and modified existing construction."

More than half of Redwood City, located next to San Francisco Bay, lies on unconsolidated, water-saturated mud. Referred to as "bay mud", this land is susceptible to failure or settlement resulting from strong ground motion during earthquakes. In 1974, the Redwood City Council adopted an ordinance to supplement the city's building code standards providing for special seismic requirements. The standards apply to lands within the city which are underlain with bay mud. Standards included in the ordinance specify foundation design, design provisions for lateral forces, foundation systems to resist settlement, elements of structural redundancy and reinforcement of structural members. The city building department requires a soils report and site investigation by a registered geologist or soils engineer with any application for development on Bay Mud. Before issuing a building permit, the building department staff verifies that the plans and construction specifications meet the city's seismic design and construction requirements.

For More Information Contact:
Planning Division, Redwood City

2. Sonoma County

"The County shall adopt, upon their approval by the International Congress of Building Officials and the State of California, any revisions to the Uniform Building Code which increases resistance of structures to earthquake-induced ground shaking..."

Since 1855, Sonoma County has experienced property damage from over 140 earthquakes. It is expected that an earthquake producing ground shaking equivalent to that experienced in the 1969 Santa Rosa earthquake will occur in the county every twenty or thirty years. The county recognizes that the greatest potential for building damage will come from ground shaking. Like most jurisdictions in California, Sonoma County has adopted the latest version of the Uniform Building Code. In addition to updating building code standards, county building officials are being kept informed of the latest standards and research in seismic design and construction.

The Seismic Safety Commission, California Building Officials, and BAREPP co-sponsor extensive training programs for building department officials in California. Based on the current edition of the Uniform Building Code, the program updates building inspectors and plan checkers on seismic design theory and all types of construction. The training, consisting of 16 sessions, is conducted by experienced structural engineers and covers both retrofit and new construction.

In 1987, 33 plan checkers attended the training held in Palo Alto. Sonoma County's Head Plan Checker was among them and is now disseminating the information he learned to other members of the Building Department and also to local structural engineers. The commitment to send just one person through the training can increase the effectiveness of an entire department.

For more information, contact:
Building Department, Sonoma County, or California Seismic Safety Commission

FLOOD HAZARDS

Earthquake-related flooding can occur in the form of tsunamis along coastlines, bays and estuaries; seiches in lakes and canals and other enclosed bodies of water; and raging torrents from the failure of dams and levees. Flooding caused by an earthquake seriously endangers both lives and property.

Getting Started

IDENTIFY FLOOD HAZARD AREAS
Historic data and other available information can be used to identify areas of high risk. Start with the flood insurance maps for your community. In addition, many federal and state agencies provide information pertinent to particular types of flood hazards. For example, check with the U.S. Geological Survey for maps of tsunami runup areas; the Governor's Office of Emergency Services for dam inundation maps and your local flood control district for information about stream and river flooding.

Partial failure of the lower dam of the Van Norman Reservoir after the San Fernando earthquake (photo: U.S. Geological Survey photo library, Menlo Park, CA)

Strategies

RESTRICT USES IN INUNDATION AREAS
Development can be restricted in coastal areas subject to tsunamis. Zoning provisions establishing setbacks from cliffs and shorelines protect the areas from other coastal flood hazards as well as tsunamis. The same principle applies to land use regulations around bays and lakes and other enclosed bodies of water.

ADOPT DESIGN STANDARDS FOR DAMS
Locating, designing and constructing dams to withstand the maximum expected earthquake forces is essential. The State of California has enacted a dam safety program requiring the assessment of dams in the state for earthquake safety.

PREPARE EVACUATION PLANS
The ability to effectively evacuate a populated area in the event of damage to a dam is essential. Evacuation plans need to be

prepared for dam inundation areas. California requires mapping of areas that would be inundated in the event of a dam failure with a reservoir at full capacity. These maps provide critical information for evacuation planning.

Examples

1. Crescent City

"The County, in conjunction with other governmental agencies, when feasible, shall utilize lands subject to severe geologic hazards for low intensity park and recreational activities or open space."

The 1964 Alaskan earthquake triggered a tsunami destroying a part of downtown Crescent City, California. Waves reaching heights of 30 feet destroyed homes and businesses and caused more than a dozen deaths. Since the earthquake, much of the area which was flooded has been filled to raise its elevation by 8 to 10 feet. The elevated area is in open space uses and serves as a buffer to protect the remaining business area from future inundation. Approximately 50 acres of the reclaimed area is now a public park and cultural center with beach area, picnic facilities, playing fields, museum, and swimming pool. The highest risk area, adjacent to the beach, is set aside for parking.

For More Information Contact:
Planning Department, Crescent City

2. San Mateo County

"Establish a priority system of evacuation routes and make provision for critical services to be provided in the event of a natural disaster, where needed to supplement existing County-wide preparedness plans."

San Mateo County has prepared a Dam Failure Contingency Plan to establish procedures for evacuating populated areas below dams. Assuming a dam failure would be associated with an earthquake, the plan is consistent with the San Mateo Operational Area Earthquake Response Plan. The plan serves as a guide for cities in the county to prepare detailed plans for response in the event of a dam failure.

Information is included for each of the thirteen dams within the county. Fact sheets provide basic data such as dam owner, area affected, approximate number of people affected and number of mass care facilities required in the event of a dam failure. Responsible city and county agencies are identified for different aspects of the response including warning and evacuation, transportation, traffic control, care of people and security. An evacuation map has been prepared for each of the dams showing command posts, assembly points, evacuation routes, key facilities for response and mass care facilities.

For More Information Contact:
Office of Emergency Services, San Mateo County

FINANCING PROGRAMS TO IMPLEMENT SEISMIC SAFETY POLICY

FINANCING ACTIONS TO IMPLEMENT SEISMIC SAFETY POLICY

Your community realizes the most important benefits of implementing seismic safety policies when an earthquake occurs. Lives will be saved, injuries averted and property damage lessened; community infrastructure will remain in operation; the costs of business disruption and consequent fiscal losses will be reduced; the costs of emergency response will be lower; and full recovery will come more quickly.

Other benefits may be realized whether an earthquake strikes or not. Actions to reduce earthquake losses may also reduce losses from other hazards such as flooding, high winds, fires and landslides. Overall improvements in administrative effectiveness and efficiency may result from steps to improve project review procedures, such as plan checking and building inspection. Careful planning of potentially hazardous areas may yield desirable open space areas for the community. Property values may be enhanced because a community is generally regarded as having effective regulations which are consistently applied.

Usually some public cost is necessary to obtain these benefits. In most cases, the costs are not extraordinary or very high, but are the usual costs of effective government operation.

The direct costs to your city or county for programs to implement seismic safety policies fall into several categories: a) costs to define seismic risks and options for risk reduction; b) ongoing administrative costs to carry out functions such as geologic review of projects; c) onetime capital improvement expenditures for projects such as seismic strengthening of a public building; and d) costs to ease the impacts of loss-reduction actions on households and businesses.

Costs to Define Seismic Risks and Options

The first step in addressing each issue described in this report is to assess the risk and define the options. In most cases, you need more detailed information and analyses than your safety element provides. The costs of obtaining the information and conducting the analyses are typically borne by local governments from their usual sources of revenue. Sometimes you can pass all or part of these costs on to the private sector or obtain funding from other governmental entities. For example, California allows local governments to seek reimbursement of the costs of data gathering, analysis and preparing a specific plan from the eventual developers of the area subject to the plan (Government Code Section 65456).

To define risks and options, you will need to assign staff to collect existing information and prepare a report evaluating options. If existing staff can do the job without sacrificing other work, the costs are quite low. However, you may decide you need more information than is available, such as detailed hazard mapping or structural evaluations of public buildings. In such cases, you will probably need an outside consultant or additional staff, and the costs can be quite high.

Remember that you can act effectively with almost any level of information. Your specific options will differ depending on the information available, but at all levels of information, you will find worthwhile options. Thus, you can start now with a program based on existing information and budget to acquire additional data over a period of time and augment your action plan accordingly.

Program Administration Costs

Staff time is the largest component of costs to administer actions implementing seismic safety policy. The trend in post-Proposition 13 California is for local governments to recover such costs as much as

possible from fees. Increasingly, applicants for various permits are required to pay for the costs of staff review and the costs of any consultants that are used for review. Other ongoing administrative costs are financed through property tax, sales tax and other conventional sources of local revenue.

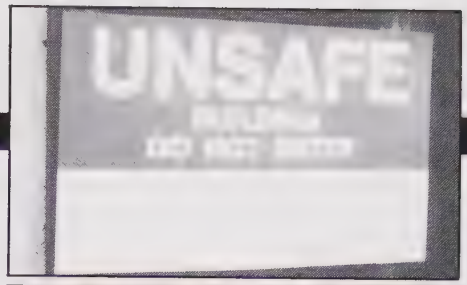
Capital Improvement Costs

You can finance capital improvements through bond issues, surcharges, property tax and other local revenues. Sometimes federal or state program funds may be available to help such as Community Development Block Grants. The specific nature of the project will determine the availability of outside funds. For example, if your project involves both seismic strenghtening and historic preservation, you may qualify for historic preservation grants. Capital improvements which are part of a redevelopment project, under California law, may be financed through tax increments. One very effective way to implement seismic safety policy is to be sure that you consider seismic risk in determining the location, design and construction of all public buildings and facilities. The added cost can be quite small for significant improvements in earthquake safety.

Costs of Impact Reduction

These costs are potentially the largest and most controversial costs of implementing seismic safety policy. The costs are optional in the sense that a local government may act within its power to protect public safety without compensating residents for losses incurred as a result of those actions. However, the community as a whole has an interest in the welfare of its people, the availability of suitable housing and the vitality of its business districts. Programs to reduce the impacts of actions to implement seismic policy express that interest. The success of some programs, particularly those addressing earthquake hazards in existing buildings, may depend on developing some means to spare the affected property owners and tenants some or most of the cost. The ability to generate the funds helps determine the pace of such programs.

The range of actions and, therefore, costs is very broad. Your city or county may decide to underwrite all or most of the private costs of complying with seismic regulations, or it may be very selective, providing assistance only in cases of extreme need or public interest. Voters in California recently approved a bond issue to fund deferred interest loans to owners of residential buildings for seismic strengthening. To be eligible the owners must agree not to raise rents. Other federal and state funds to provide and preserve low and moderate income housing may be applicable. Local governments may establish a low-interest loan program to help building owners, provide for temporary housing, offer property tax relief, reduce project application fees, or any of a number of other measures to ease the burden of complying. The best list of sources of funds for various seismic safety programs is *Resources Inventory and Evaluation* complied by David Prowler for the City of San Francisco. Copies are available from BAREPP.



LEGAL ISSUES IN IMPLEMENTING SEISMIC SAFETY POLICY

LEGAL ISSUES IN IMPLEMENTING SEISMIC SAFETY POLICY

The most common legal issue regarding seismic safety programs is liability. Local jurisdictions are sometimes left with the uneasy impression that they are in a double bind--liable if they act to reduce earthquake hazards and also liable if they fail to act. In fact, both may be true. Some actions that reduce earthquake hazards are in the quite large gray zone between the turfs of public responsibility and private property rights.

Your local government can be held liable for failure to correct hazardous conditions in public property or to meet a statutory requirement like inventorying URM buildings. You also may be liable if actions which regulate the use of private property are deemed a "taking" by the courts. In general, local government is more likely to be held liable for damages arising from hazardous conditions in public buildings than from regulatory actions.

You face the same legal questions preparing regulations to reduce earthquake losses that you confront with many other kinds of regulations. Your general plan must meet the requirements of state law or the courts can invalidate your development regulations. By law, the safety element is to protect the community from "unreasonable risks" from earthquakes and other hazards. An element that clearly identifies and evaluates hazards and contains policies to reduce risks from the identified hazards provides a solid foundation for regulatory programs. It is important to be able to demonstrate that actions are closely related to the state-mandated purpose.

The state has granted immunity from liability for certain kinds of actions. For example, local governments are not liable for action or inaction taken to carry out the state URM law requiring the inventory of unreinforced masonry buildings. Similarly, local governments are not liable for many actions of public employees while responding to a disaster. Nor are they liable for failing to discover hazards when inspecting private buildings. Your city or county attorney can give you current information about state legislation that affects local government immunities from liability.

As with other government actions, the decisionmaking process should be systematic, well-documented and allow for adequate public participation. Systematic implies a process that goes logically from the general to the specific. The general plan goals provide a context for seismic safety policies which in turn provide the context for regulatory actions and programs. It is important to be able to show how a given action fits into this scheme. Careful attention to procedures and documentation of actions at all stages builds the best possible case in the event the action is challenged.

In all cases, local governments are urged to take responsible action to protect the public health, safety and welfare based upon careful analysis and documentation of the basis for action, and also to follow procedures which allow for full public consideration of the issue.

In short, one clear way to avert liability losses is to identify and correct hazards in public facilities. In addition, a general practice of making careful decisions according to clear and open procedures will go a long way in protecting a local jurisdiction in the event of a lawsuit. Simply stated, good government practices are the best protection. After the earthquake, you can expect to be held accountable for failures to act to reduce losses. At that time, no preventive action taken beforehand will be viewed as "going too far".

SOURCES OF INFORMATION

A wealth of information on earthquakes and how to prepare for them is as close as your telephone. Your first call should be to the regional earthquake preparedness agency closest to you:

For Northern California, contact:

Bay Area Regional Earthquake Preparedness Project (BAREPP)
MetroCenter, 101 8th Street Suite 152
Oakland, CA 94607
(415) 540-2713

Southern California, contact:

Southern Californa Earthquake Preparedness Project (SCEPP)
600 Commonwealth Boulevard, Suite 1100
Los Angeles, CA 90005
(213) 739-6695

These two agencies, administered by the Governor's Office of Emergency Services and partly funded by the Federal Emergency Management Agency, are specifically charged with assisting local governments in the state to reduce earthquake vulnerability. BAREPP and SCEPP maintain resource centers with documents and visual materials on earthquake safety and knowledgeable staff members to help you find answers to your specific questions.

Another key source is the California Seismic Safety Commission.

California Seismic Safety Commission
1900 K Street, Suite 100 Sacramento, CA 95614
(916) 322-4917

The Commission's main function is to advise state agencies and the legislature on issues regarding seismic safety. The Commission prepared and updates the state's plan to reduce seismic hazards. The plan, CALIFORNIA AT RISK--REDUCING EARTHQUAKE HAZARDS 1987-1992, defines existing and planned programs and actions of state agencies to reduce seismic risk. The plan lets you know what commitment the state has made as a context for considering the appropriate actions for your local jurisdiction. The Commission also has issued two reports specifically designed to help local governments improve seismic safety:

CALIFORNIA AT RISK--STEPS TO EARTHQUAKE SAFETY FOR LOCAL GOVERNMENT describing 30 actions that can be taken at the local level to increase seismic safety in existing development, emergency planning and response, future development and recovery.

GUIDEBOOK TO IDENTIFY AND MITIGATE SEISMIC HAZARDS IN BUILDINGS outlining how local governments can carry out the mandate of SB 547 requiring each city and county to inventory existing URM buildings and prepare a mitigation program.

You can find general information about earthquakes and local government efforts to reduce the risks through land use planning in the following publications:

SEISMIC SAFETY AND LAND-USE PLANNING, Selected Examples from the San Francisco Bay Region, California, 1979, U.S. Geological Survey Professional Paper 941-B, U.S. Government Printing Office, Washington, D.C.

REDUCING EARTHQUAKE RISKS: A PLANNER'S GUIDE, 1981, PAS Report Number 364, American Planning Association, 1313 E. 60th Street, Chicago, IL 60637.

LAND USE PLANNING FOR EARTHQUAKE HAZARD MITIGATION: A HANDBOOK FOR PLANNERS, 1986, Special Publication 14, Natural Hazards Research and Applications Information Center, University of Colorado, Boulder, CO.

The best list of sources of funds for various seismic safety programs is RESOURCES INVENTORY AND EVALUATION compiled by David Prowler for the City of San Francisco. Copies are available from BAREPP.

For additional information on any of the examples cited in this report, please contact the jurisdiction directly.

BAREPP

BAY AREA REGIONAL
EARTHQUAKE PREPAREDNESS
PROJECT

OES
CALIFORNIA

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Emergency Services